1909.		Gr. M. T.	y	
Jan. 2.	Te.	$15^h.0$	6″.4	North
	Di.	19 .2	7 .4	
4.	Te.	12 .3	6 .4	
5.	Di.	12 .9	7 .4	
6.	Te.	9 .6	6 .4	
8.	Di.	6 .6	7 .4	
	Te.	6 .9	6 .4	
10.	Te.	4 .2	6 .4	
11.	Di.	0 .3	7 .4	
12.	Te.	1 .6	6 .4	
13.	Di.	18 .0	7 .5	
	Te.	22 .9	6 .4	
15.	Te.	20 .2	6 .4	

1909.		Gr. M. T.	y	
Jan 16.	Di.	$11^h.8$	7″.5	North
17.	Te.	17 .5	6 .4	
19.	Di.	5 .5	7 .5	
	Te.	14 .8	6 .4	
21.	Te.	12 .2	6 .5	
	Di.	23 .2	7 .5	
23.	Te.	9 .5	6 .5	
24.	Di.	16 .9	7 .5	
25.	Te.	6 .8	6 .5	
27.	Te.	4 .1	6 .5	
	Di.	10 .6	7 .5	
29.	Te.	1 .4	6 .5	

THE CORONAL SPECTRUM AS OBSERVED AT THE FLINT ISLAND ECLIPSE.

By W. W. Campbell and Sebastian Albrecht.

Two single-prism spectrographs were designed by Mr. Campbell for efficiency in recording the continuous spectrum of the corona. These and a three-prism spectrograph, referred to below, were mounted on one clock-driven polar axis. All were adjusted by Mr. Albrecht, assisted by Mr. Merfield, and the programme of observations at the time of the eclipse was carried out perfectly by Mr. Merfield. The slits of the three instruments extended east and west centrally across the Sun's image.

One of the single-prism instruments, using a Seed plate No. 27, was exposed from $0^m\ 5^s$ to $3^m\ 51^s$. The spectrum of the extreme inner corona is recorded from λ 3550 to λ 5390. It is very strong for the first 2′ from the limb; the intensity falls off gradually out to a distance of 15′–20′ from each limb; and the intensity is then nearly uniform out to the ends of the slit, 49′ on the east side of the Sun and 40′ on the west. A continuous spectrum covers the region corresponding to the Moon, the intensities near the ends of the slit being slightly less than over the Moon.

A brilliant prominence on the east limb is the origin of a great number of overexposed bright lines. The following prominence lines are lengthened by the diffusion of the light in our atmosphere; their extent, measured from the east limb of the Moon being:—

$H\eta$	East 20′,	West 20′	
$H\zeta$	30	30	
K	49	72	Full length of slit, strong.
$H(+H\epsilon)$	49	72	" " " " "
$H\delta$	49	33 +,	Ends in west coronal spectrum.
$H\gamma$	49	33 +,	" " " " "
λ 4471	30	30	Very faint.
$H\beta$	49	33 +,	Ends in west coronal spectrum.

A longer slit would no doubt have given still greater extent to the lines now limited at 49′ and 72′. The H and K calcium lines, especially, terminate abruptly at the points on the plate corresponding to the slit-ends.

The green bright line at λ 5303 and a bright line at λ 3601.3, the latter apparently new, are recorded in good strength, each out to 3′ from the west limb and 2′ from the east; the coronal line measured at λ 3987.0 is faintly visible, apparently lengthened by diffusion, on the strong continuous spectrum; the well-known coronal line measured at λ 4231.5 is easily visible, extending by diffusion entirely across the Moon and to the ends of the slit; a faint line at λ 3625.5, showing on both sides of the Sun, is short, but apparently a new coronal line; a faint line, visible on both sides, at λ 3643.3, and a more difficult line, showing only on the east side, at λ 3801.0, are probably coronal lines that have been observed before; a line 2′ long, showing only on the east side, at λ 3641.3, is of doubtful reality, and all other coronal bright lines appear to be lost in the strong continuous spectrum, the dispersion being low. The spectrum of the inner corona seems to be free from absorption-lines, at least out to 8′ or 10′ from the limb. The absorption-lines show very faintly in the spectrum of the outer corona, and still more faintly (and doubtfully) in the Moon's area, especially in the region λ 3900–4500. They are most readily observed in the regions lying between 10′ and 20′ from the limb. The maximum intensity of continuous

spectrum, estimated to lie at λ 4675, seems perceptibly further to the red than the maximum on the solar spectrograms obtained with the same instrument at Mt. Hamilton,—signifying a lower effective temperature in the corona than in the Sun.

Cramer isochromatic instantaneous plates were used with the other single-prism instrument. One exposure, from $0^m\ 3^s$ to $0^m\ 20^s$, recorded nothing, no doubt on account of the clouds then prevailing. Another exposure, from $0^m\ 30^s$ to $3^m\ 51^s$, recorded the coronal spectrum very strongly. The spectrum for the inner corona extends from λ 3600 to λ 6000, all in good focus. The above description of the coronal spectrogram on the Seed plate applies in general to this spectrogram, taking its isochromatic character into account. The slit extended 47′ east of the Sun's image and 35′ west. The hydrogen and calcium lines of the prominence are likewise lengthened by diffusion, the *H* and *K* lines of calcium extending the full length of the slit,—47′ east and 68′ west from the prominence; the merest trace of an absorption spectrum is visible likewise in the mid-coronal region, and only in the violet. The intensities in the regions near the ends of the slit are clearly less than over the Moon.

The green coronal line, measured at λ 5301.4 ± 0.5, is strongly recorded, certainly to 20′ on the west and 15′ on the east. However, as this line is easily visible across the Moon's area, the great lengths are doubtless due in large measure to diffusion in our atmosphere. The bright coronal line at λ 4231.2 ± 0.2 is also recorded as of great length, especially on the west side. λ 3986.9 ± 0.2 is long but very difficult. A number of other coronal lines are suspected, but the strong background of continuous spectrum renders their existence uncertain. The dispersion being low, the wave-lengths assigned above are subject to slight error.

The interpretation of these spectrograms is a difficult matter, as the subject is more complex than it at first seems. There can be little doubt that the coronal spectrum combines three types:—bright-line, continuous, and dark-line. It further seems clear that *each point of the slit* receives light, by diffusion, from every prominence, from every point in the uneclipsed chromosphere, and from every point in the corona.

If the *H* and *K* calcium light is diffused in our atmosphere to cover the slit strongly to a distance of at least 72′ from the east limb, the apparent center of the effective diffusion, the brilliant light of the entire inner corona must by similar diffusion fall upon the entire length of the slit. We believe that this diffused inner-coronal light is chiefly responsible for the spectrum corresponding to the ends of the slit, and to that part of the slit covered by the Moon's image, and that ordinary sunlight diffused in the air in front of the instrument, from the illuminated atmosphere outside of the Moon's shadow, has contributed very little to the recorded spectrum. Thus the spectrum covering the Moon's section, neglecting diffused prominence and chromospheric radiations, is almost wholly a coronal spectrum. If it were in good part due to photospheric light, the absorption spectrum would be conspicuous; and the same could be said for those areas of the spectrogram corresponding to the ends of the slit. In fact, the true spectrum of the outer corona, say beyond 20′ from the limb, is either not recorded at all, or is masked by the superposed spectrum due to diffused light from the brilliant inner corona. It was remarked by the observers with previous experience—Messrs. PERRINE, ABBOT, and CAMPBELL—that the outer corona, as viewed by the naked eye, was disappointingly faint.

The proportion of light radiated by coronal particles appears to have been relatively large, and the sunlight diffused by the coronal particles relatively small, on this occasion. It appears that only in the region of the plates corresponding to the middle corona are the proportions of radiation spectrum, absorption spectrum (sunlight), and diffused inner-coronal spectrum such as to let the faintest traces of absorption-lines be detected. We do not feel that these facts militate against the theory of the corona held for several years by the Lick eclipse observers. Whether the stronger absorption spectra observed in Sumatra in 1901 and in Spain in 1905 indicate a variable coronal spectrum or the influence of the thin clouds over the corona in 1901 and 1905, is a question for future consideration.

A spectrograph of high dispersion, containing three extremely dense glass prisms, was used in the hope of recording the green coronal line, in order to determine its wave-length

with great accuracy. The solar spectrum was impressed upon the plate immediately after the end of the total eclipse, for reference. No trace of the coronal line exists on the plate, undoubtedly because of the strong absorption of the prisms.

TABLES OF THE ELEMENTS OF COMET-ORBITS, JANUARY, 1896, TO DECEMBER, 1907.

By J. C. Duncan.

The following tables have been prepared at the suggestion of Director Campbell, to supplement those compiled by W. C. Winlock, and published in *Publications* of the A. S. P., Vol. VIII, p. 141. Professor Winlock's tables include all the comets whose orbits were known and which reached perihelion before January 1, 1896; the tables here presented complete the list up to the present time.

The data were derived from the various astronomical periodicals, chiefly from the *Astronomische Nachrichten* and the *Astronomical Journal.* In each case that set of elements was chosen which most nearly represented the path of the comet.

Table I gives the elements of comets in order of perihelion passage. The numbers in the first column are continued from those of Winlock, which are identical with the numbers in Dr. Galle's catalogue of comet-orbits. The second column contains the designation of the comet according to the order of its discovery; in the case of well-known periodic comets this is followed by an abbreviation of the name of the comet's discoverer. These abbreviations are as follows:—

d'A = d'Arrest	Ho = Holmes
Bk = Brooks	T_2 = Tempel (second comet)
E = Encke	Tu = Tuttle
F = Fayé	W = Winnecke
Fi = Finlay	Wo = Wolf

The third and following columns give the orbital elements, as follows:—